

Such strategies could be implemented through cooperative agreements with land management agencies or through conservation easements or purchase from willing sellers.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological management zones will also allow natural floodplains, meander corridors, seasonal pools, and riparian vegetation to develop that will provide habitat for these species elsewhere in the Central Valley.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Other existing programs that will directly or indirectly improve and restore habitat for shorebirds and wading birds include:

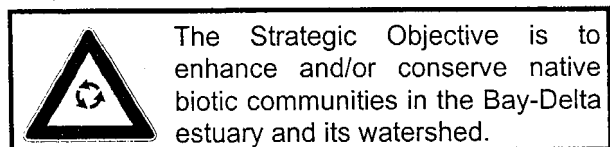
- Bay Area Wetlands Planning Group,
- Central Valley Habitat Joint Venture,
- Cosumnes River Preserve,
- Grizzly Slough Wildlife Area,
- San Francisco Bay National Wildlife Refuge,
- Sonoma Baylands Project,
- Tidal Wetlands Species Recovery Plan,
- Yolo Basin Wetlands Project, and
- San Francisco Bay Wetlands Ecosystem Goals Project.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Protection and restoration of shorebirds and wading birds is integrally linked with restoration of perennial aquatic, wetland, and riparian habitats and reduction in human disturbance.

OBJECTIVE, TARGETS, AND ACTIONS

SHOREBIRDS



SPECIES TARGET: Improve populations and distribution of shorebirds birds.

LONG-TERM OBJECTIVE: Provide sufficient high-quality tidal and shallow water foraging habitat and upland roosting habitat to maintain large populations of all members of this guild that now occur in central California, while also providing sufficient nesting habitat for species that breed in the state.

SHORT-TERM OBJECTIVE: Maintain wintering and breeding populations at their present levels and increase populations of all threatened species sufficiently to be able remove them from lists of threatened species.

RATIONALE: The shorebird guild is an extremely diverse group of migratory and resident species (e.g., sandpiper, plover, curlew, avocet) that forage, often in mixed flocks, on invertebrates in tideflats, beaches, shallow ponds, and other shallow water areas. The Central Valley, Delta, Suisun Bay and Marsh, and San Francisco Bay are a major wintering areas for birds that breed in more northern areas, as well as staging areas for birds headed further south. Habitats suitable for shorebirds were once abundant throughout the region. However, human disturbance, filling of shallow water areas, and other forms of degradation have caused suitable foraging habitats to become diminished. These smaller and more disjunct patches of habitat have made concentrations of shorebirds more susceptible to human disturbance and to increased predation. This guild contains species that are listed as threatened by both state and federal governments (e.g., snowy plover) while others are considered to be species of special concern.

STAGE 1 EXPECTATIONS: CALFED will have cooperated with the Central Valley Habitat Joint Venture to implement the Venture's goals and objectives that relate to creating habitat for shore birds. An evaluation of threats to foraging and breeding habitats will have been conducted and ways found to alleviate threats. Areas that can be restored as foraging areas, especially tide flats, will have been identified and restoration work begun.

WADING BIRDS



The Strategic Objective is to enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.

SPECIES TARGET: Improve populations and distribution of wading birds.

LONG-TERM OBJECTIVE: Provide sufficient high-quality breeding and foraging habitat for all wading bird species so that the guild will continue to be diverse and abundant.

SHORT-TERM OBJECTIVE: Maintain wading bird numbers and diversity at their present level, as a minimum.

RATIONALE: The wading bird guild is a group of mostly conspicuous birds (herons, egrets, bitterns, ibis) that wade in the water to forage on fish and other aquatic organisms. Because egrets and herons are so conspicuous along the waterways of the Bay-Delta watershed, they have high symbolic value for ecosystem restoration. Some members of the guild (least bittern [treated separately] and white-faced ibis) are state species of special concern. Habitats suitable for foraging of wading birds are still common throughout the Bay-Delta watershed. However, human disturbance and degradation has caused many of these habitats to become isolated, polluted, or subject to high levels of disturbance. For many of the species, the principal limiting factor is availability of adequate nesting (rookery) habitats. Long-term persistence of this group of birds in abundance depends on extensive areas of shallow water (less than 1.5 feet deep) containing abundant food, in conjunction with riparian habitats suitable for breeding.

STAGE 1 EXPECTATIONS: CALFED will have cooperated with the Central Valley Habitat Joint Venture to implement the Venture's goals and objectives that would increase foraging habitat for this guild. In addition, existing heron and egret rookeries will have been protected and other potential rookery areas identified.

RESTORATION ACTIONS

The following general targets will assist in meeting

the implementation objective:

- Increase the number of shorebirds and wading birds over present levels.
- Increase the distribution of shorebirds and wading birds.
- Increase the quantity and quality of overwintering and resting habitat.

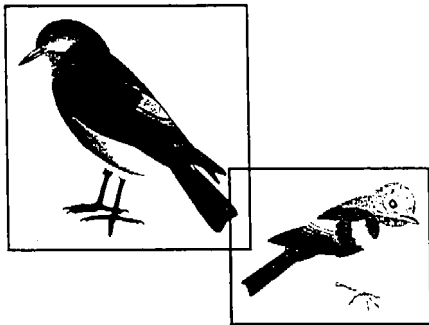
The following general programmatic actions will assist in meeting the targets:

- Increase the amount of riparian habitat in the Central Valley.
- Increase the amount of perennial aquatic habitat in the Central Valley.
- Increase the amount of emergent and seasonal wetlands in the Central Valley.
- Improve water management and land use practices to benefit wading birds' and shorebirds.
- Limit disturbance to nesting, roosting, and foraging habitats.

REFERENCE

Strategic Plan for Ecosystem Restoration. 2000.
CALFED Bay-Delta Program, Programmatic
EIS/EIR Technical Appendix. July 2000.

◆ NEOTROPICAL MIGRATORY BIRD GUILD



INTRODUCTION

Neotropical species breed in North America and winter in Central and South America. Many species of neotropical migratory birds migrate through or breed in the Bay-Delta. These species are a significant component of the ecosystem. These species are of high interest to recreational bird watchers, and contribute to California's economy through sales of equipment and other bird-watching-related expenditures. There have been substantial losses of historic habitat used by these species and available information suggests that population levels for many of these species is declining.

Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of native habitats for agricultural, industrial, and urban uses, and land use practices that degrade habitats used by these species.

RESOURCE DESCRIPTION

The neotropical migratory bird guild comprises bird species that breed in North America and winter in Central and South America. Representative species of the neotropical migratory bird guild are the western kingbird, western wood-pewee, tree swallow, cliff swallow, northern oriole, Wilson's warbler, and yellow-breasted chat. Individual visions are developed for some neotropical migrants, such as the Swainson's hawk and yellow-billed cuckoo, and those visions contain more specific targets relating to those species. All species of the neotropical migratory bird guild depend on the flora of California to forage and reproduce, typically from about May until

September. The birds normally spend the rest of the year in Central and South America.

Neotropical birds occur throughout the California and are associated with most of California's habitat types, including forested woodlands, riparian and montane riparian habitats, unforested lowlands, grasslands, shrub habitats, valley foothill hardwood, valley foothill hardwood-conifer, and wetlands. Population levels of many of these species has declined, primarily as a result of the loss and degradation of habitats on which they depend, both in California and on their Central and South American wintering areas. In California, the quality and quantity of important neotropical migrant bird habitats have been substantially reduced primarily by their conversion to agricultural, industrial, and urban uses, and land use practices that degrade the values provided by these habitats.



VISION

The vision for the neotropical migratory bird guild is to maintain and increase healthy populations of neotropical migratory birds through restoring habitats on which they depend.

Protecting existing and restoring additional suitable wetland, riparian, and grassland habitats will be critical to maintaining healthy neotropical migrant bird populations in the Bay-Delta. Large-scale restoration of nesting habitat will help reduce nest parasitism and predation by creating habitat conditions that render neotropical birds less susceptible to these stressors. Restoration of these habitats in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Management Zones will help maintain healthy populations by increasing the quality and quantity of habitats used by these species. Restoration of ecosystem processes and habitats in other ecological management zones will also allow natural floodplains, stream meanderings, seasonal pools, and riparian vegetation to develop that will provide habitat for these species elsewhere in the Central Valley.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Related restoration programs include:

- Central Valley Project Improvement Act,
- Cache Creek Corridor Restoration Plan,
- Cosumnes River Preserve,
- Riparian Habitat Joint Venture,
- Upper Sacramento River Advisory Council's Riparian Habitat Committee (SB1086 program),
- San Joaquin River Management Program, and
- U.S. Fish and Wildlife Service's Anadromous Fish Restoration Plan.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Restoration of neotropical migratory birds is integrally linked with restoration of wetland, riparian, grassland, and forest habitats.

OBJECTIVE, TARGETS, AND ACTIONS



The Strategic Objective is to enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.

SPECIES TARGETS: Increase the abundance and distribution of neotropical migratory birds in the Central Valley.

LONG-TERM OBJECTIVE: Substantially improve breeding and migration habitats for all neotropical migrant birds to increase their rates of reproduction and survival.

SHORT-TERM OBJECTIVE: Maintain neotropical migratory bird breeding populations at present levels and develop restoration projects that will benefit migrating individuals.

RATIONALE: Neotropical migratory birds constitute a diverse group of largely passerine songbirds that overwinter in the tropics but breed in

or migrate through the Central Valley and Bay-Delta region. As a group, they are in decline because of loss of habitat on their breeding grounds, in their migratory corridors, and in their wintering grounds. The species within this group are good indicators of habitat quality and diversity and their popularity with birders means that populations are tracked and have high public interest. They can also be good indicators of contaminant levels, by monitoring reproductive success and survival in areas near sources of contamination. Riparian forests are particularly important to this group because they are major migration corridors and breeding habitat for many species. By providing improved nesting and migratory habitat, it may be possible to partially compensate for increased mortality rates in the wintering grounds. Improved habitat for songbirds also provides habitat for many other species of animals and plants.

STAGE 1 EXPECTATIONS: A "master plan" for the conservation of neotropical migrants in the Bay-Delta watershed that includes status reports and habitat requirements for all species will have been completed. This information will have been used to integrate neotropical migrant conservation into various CALFED restoration projects or to develop restoration projects specifically aimed at improving migration and breeding habitat for selected members of this group.

RESTORATION ACTIONS

The following general targets will assist in meeting the implementation objective:

- Increase populations of neotropical birds in the Central Valley.
- Increase the distribution of neotropical birds in the Central Valley.

The following general programmatic actions will assist in meeting the targets:

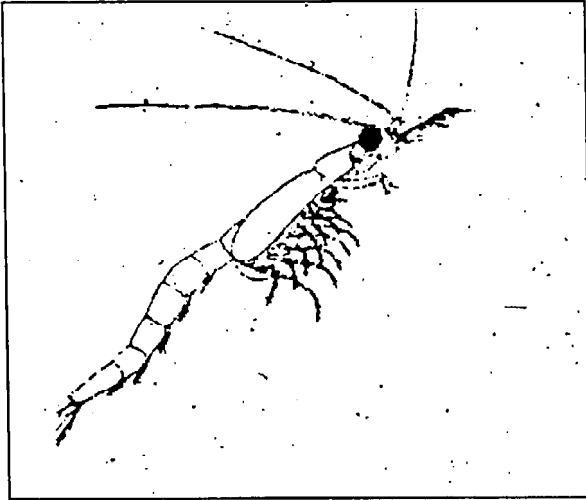
- Increase wetland, riparian, grassland and habitats in the Central Valley.
- Improve upper watershed health.
- Improve specific nesting habitats for individual species within their existing and restored habitats.

- Protect nesting habitats from predators and human disturbance.

REFERENCE

Strategic Plan for Ecosystem Restoration. 2000.
CALFED Bay-Delta Program, Programmatic
EIS/EIR Technical Appendix. July 2000.

◆ BAY-DELTA AQUATIC FOODWEB ORGANISMS



INTRODUCTION

Bay-Delta aquatic foodweb organisms include bacteria, algae, zooplankton (e.g., copepods and cladocerans), epibenthic invertebrates (e.g., crayfish, *Neomysis* and Crangon shrimp), and benthic invertebrates (e.g., clams). Foodweb organisms are essential for the survival and productivity of fish, shorebird and other higher order animal populations in the Bay-Delta estuary. Some organisms are non-native species (e.g., certain zooplankton and Asian clams) that may be detrimental to native species and the foodweb in general. Recent declines in aquatic foodweb organisms of the Bay-Delta, particularly in drier years, has caused a reduction in overall Bay-Delta productivity. Important aquatic foodweb organisms include algae, bacteria, rotifers, copepods, cladocera, and mysid shrimp.

RESOURCE DESCRIPTIONS

The foodweb of the Bay-Delta ecosystem consists of all the plants, invertebrates, and other lower trophic-level organisms that serve as prey for fish, water birds, and other higher trophic-level resources of the ecosystem. Foodweb productivity of the Bay-Delta estuary is dependent primarily on the supply of nutrients and plant biomass production and transport (See Bay-Delta Aquatic Foodweb Process).

Plant communities in the Bay-Delta aquatic foodweb consist mostly of benthic algae and phytoplankton produced in the estuary and its watershed, and vascular-plants in riparian and wetland communities adjacent to the system. Algae are generally small (diameter <0.1 millimeters [mm]), easily transported, and highly nutritious. Phytoplankton are related to algae but small enough to float in the water. Most vascular-plants, by contrast, are much larger.

The Bay-Delta foodweb has undergone a number of changes since the 1960s. Most notably, phytoplankton abundance has declined in important fish nursery areas of Suisun Bay and the western Delta (Lehman 1996). A pattern of very low phytoplankton levels in Suisun Bay and the Delta beginning in 1987 concerns many scientists. Low levels in Suisun Bay and the Delta since 1986 may be the result of high densities of Asian clams (*Potamocorbula amurensis*) that colonized the Bay after being accidentally introduced from the ballast waters of ships. Large numbers of the clams colonized this area of the estuary during the drought period from 1987 to 1992 (Kimmerer and Orsi 1996).

Aquatic invertebrate population trends followed those of phytoplankton over the past three decades. Species that once dominated the aquatic invertebrate community have become relatively scarce, while some others have increased in relative abundance. Many native species have become less abundant or more narrowly distributed, while dozens of new non-native species have become well established and widely dispersed. In general, the abundance of plankton has declined, while populations of many bottom-dwelling invertebrates, most notably Asian clams, have increased. This transition has been most evident in Suisun Bay and other traditionally important fish-rearing areas. Also in these areas, populations of rotifers, copepods, and other relatively small species have declined substantially since monitoring began in the 1960s (Kimmerer and Orsi 1996). This pattern is perhaps most dramatic for the mysid shrimp, which have declined to less than one-tenth of their former abundance, particularly since 1986 (Orsi and Mecum

1996). The continued decline from 1993 to 1995, despite the return of higher flows, is of particular concern. These declines in zooplankton abundance have roughly coincided with the decline in algae, one of the main food sources for the zooplankton.

The deterioration of the zooplankton community and its algal food supply in key habitat areas of the Bay-Delta is a serious problem because striped bass, delta smelt, chinook salmon, and other species that use Suisun Bay and the Delta as a nursery area feed almost exclusively on zooplankton during early stages of their life cycles. Research indicates that survival and growth of fish larvae generally increase with increased concentration of zooplankton. Declines in the production of juveniles of these fish species appear to coincide with the declines in algae and zooplankton. Modifying the Bay-Delta ecosystem in ways that will lead to increased algae and zooplankton abundance may be critical to restoring Bay-Delta fish populations and improving the health of its ecosystem.

Areas of the Bay-Delta where hydraulic conditions allow food resources to accumulate in the water column rather than settling or washing out are important habitats for plankton foodweb organisms. This accumulation of food resources results from passive processes and from active algal, microbial, and zooplankton reproduction. The comparatively benign hydraulic conditions and abundant food resources characterizing the western Delta and Suisun Bay permit the development of high zooplankton populations on which many estuarine resident and anadromous fish depend during their early life stages. Horizontal salinity stratification enhances this process, especially when the salinity front (sometimes referred to as X2) or the "entrapment zone" is in Suisun Bay (Arthur and Ball 1979).

The decline of plankton populations in the Bay-Delta may also be a result, at least in part, of the effects of heavy metals, herbicides, pesticides or other toxic substances. Low concentrations of these substances in the water column may act individually or in combination to reduce productivity of plant and animal plankton. Research to determine the effects of these toxicants on plankton is currently underway.



VISION

The vision for the Bay-Delta aquatic foodweb organisms is to restore the Bay-Delta estuary's once-productive food base of aquatic algae, organic matter, microbes, and zooplankton communities.

Restoring the Bay-Delta foodweb organisms would require enhancing plankton growth and reducing loss of plankton to water exports, particularly in drier years. Several options exist for enhancing plankton growth. Improving Delta inflow and outflow in spring of drier years will be an essential element of any plan. Other elements include reducing losses to exports from the system and reducing the amount of toxic substances entering the system.

Additional improvements can be gained by increasing shallow-water habitat and tidal wetlands in the Bay and Delta. Increasing the acreage of floodplain lakes, sloughs, and other backwaters in the Sacramento River drainage will increase organic matter inputs to the Delta. This increase in plankton food supply will help increase population growth.

Restoring tidal action to leveed lands in San Pablo Bay and Suisun Marsh will increase habitat for aquatic foodweb organisms. The Yolo and Sutter Bypasses offer potential opportunities to produce more permanent slough, riparian, and wetland habitats in the Sacramento River floodplain. Setback levees or improved riparian and shallow-water habitat along leveed reaches of the rivers and Delta offer additional opportunities to increase the abundance of foodweb organisms in the Bay and Delta.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Efforts to restore the abundance of Bay-Delta aquatic foodweb organisms would involve the cooperation and support from established programs underway to restore habitat and fish populations in the Bay-Delta including the following:

- The Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes calls for improving flows, reducing diversions, and increasing habitat.
- The Salt Marsh Ecosystem Recovery Plan calls for improving wetland habitat in the Bay.

- The Central Valley Project Improvement Act (PL 102-575) and its associated Anadromous Fish Restoration Plan include provisions to reduce losses of organisms into water diversions, to restore aquatic habitat, to improve water quality, to improve freshwater flows, and to restore wetland and riparian habitats in the rivers and Bay-Delta.
- The Steelhead Trout, and Anadromous Fisheries Program Act of 1988 includes elements to improve freshwater flows and riparian habitats in the Sacramento and San Joaquin Rivers and their tributaries.
- The Delta Wildlife Habitat Protection and Restoration Plan include protection and improvements to riparian and wetland habitats of the Bay-Delta.
- Central Valley Habitat Joint Venture includes restoration of riparian and wetlands of the rivers, Delta, and Suisun Marsh.
- California Senate Concurrent Resolution 28 has set a goal of doubling wetland acreage by the year 2000.
- San Francisco Estuary Project planning for wetland protection and restoration, and water quality protection and improvement.
- San Joaquin River Management Plan is a plan to restore riparian and wetland habitat and improve water quality in the San Joaquin River and its tributaries.
- SWRCB and RWQCB efforts to restore wetlands and improve water quality of the rivers and Bay-Delta.
- Suisun Resource Conservation District is developing wetlands restoration and management plans.
- Riparian Habitat Joint Venture will restore riparian habitats.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Improving the abundance and distribution of important aquatic foodweb organisms of the Bay-Delta is integrally linked with wetland and riparian

habitat restoration, water quality (contaminants) improvement, and Central Valley streamflow improvements.

OBJECTIVE, TARGETS, AND ACTIONS



The Strategic Objective is to enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.

SPECIES TARGET: Increase populations and distribution of important foodweb organisms in Delta channels and reduce competition with invasive non-native species.

LONG-TERM OBJECTIVE: Increase abundance of zooplankton to the levels that existed prior to the introduction of the Asiatic clam, *Potamocorbula amurensis*, with zooplankton communities containing native species as significant components.

SHORT-TERM OBJECTIVE: Maintain the planktonic assemblages at roughly the range of variability of abundance and composition that they have been since the Asiatic clam became established by preventing new introductions and determining conditions that favor native organisms such as *Neomysis mercedis*.

RATIONALE: The long-term objective is quite likely impossible to achieve because recent invading species, from the Asiatic clam to various crustacean zooplankters, will continue to play major ecological roles in the system, to the detriment of native organisms. However, at the very least it is possible to stop further introductions of non-native species which have the potential to further change the system unpredictably. This objective is also a call to develop a thorough understanding of the planktonic portion of the Bay-Delta system to predict and understand the impacts of large-scale ecosystem alteration projects on the plankton.

STAGE 1 EXPECTATIONS: Major steps will have been taken to halt activities (e.g., dumping of contaminated ballast water) that result in the establishment of new species of invertebrates and fish in the estuary. Further development of our understanding of the how the Bay-Delta system

functions should allow recommendations on how to maintain native zooplankton species, in the context of broader ecosystem management goals.

RESTORATION ACTIONS

General targets that will assist in meeting the implementation objective include:

- Increase abundance of important food web organisms to 1960s level of abundance
- Reduce influence of non-native species in foodweb communities
- Improve distribution of important foodweb organisms in Bay-Delta.

General programmatic actions that will contribute to achieving the targets include:

- increase late winter and spring Delta outflow
- reduce losses to water diversions
- opening leveed lands to tidal or seasonal floodflows
- increasing the array of sloughs in the Delta
- reduce influx of non-native species
- protecting and restoring shallows, shoals, and channel islands in the Delta; and
- providing more natural floodplains and meander belts along rivers.

REFERENCES

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◆ PLANT COMMUNITY GROUPS

AQUATIC HABITAT PLANT COMMUNITY GROUP

INTRODUCTION

Aquatic plant habitat in the Bay-Delta area is present in permanently flooded and intermittently exposed shallow water areas. These shallow water areas present important wetland habitat for dependent plant, wildlife, and fish species. The substantial loss of historic shallow water aquatic plant habitat has primarily resulted from reclamation and channel dredging and scouring. Loss of such habitat has reduced primary (plant) and secondary (invertebrate) productivity in the Bay-Delta area, changing important characteristics of the natural foodweb of the system and therefore leading to the decline of many native plant, fish, and wildlife species.

RESOURCE DESCRIPTION

PONDWEEDS WITH FLOATING AND SUBMERGED LEAVES. Aquatic plant habitat in the Bay-Delta area is dominated by pondweeds (*Polygonum* spp.) with floating or submerged leaves. Pondweeds are the sole or dominant herb in this community. Pondweeds with submerged leaves include crispate pondweed (*P. crispus*), eel-grass pondweed (*P. zosteriformis*), fennelleaf pondweed (*P. pectinatus*), leafy pondweed (*P. foliosus*), Nevada pondweed (*P. latifolius*), Richardson pondweed (*P. richardsonii*), Robbin pondweed (*P. robbinsii*), slenderleaf pondweed (*P. filiformis*), small pondweed (*P. pusillus*), and whitestem pondweed (*P. praelongus*). Pondweeds with floating leaves include alpine pondweed (*P. alpinus*), broadleaf pondweed (*P. amplifolius*), diverseleaf pondweed (*P. diversifolius*), floatingleaf pondweed (*P. natans*), grassleaf pondweed (*P. gramineus*), longleaf pondweed (*P. nodosus*), Nuttall pondweed (*P. epihydrus*), and shinning pondweed (*P. illinoensis*). The vegetative cover in the aquatic plant habitat ranges from continuous to intermittent or open.



VISION

The vision for plant community groups is to maintain and restore existing and rehabilitate degraded habitats that support the diverse assemblages of plants in the Bay-Delta.

The vision will be attained by protecting and restoring large areas of perennial shallow water that provide habitat for pondweeds and other associated plant and wildlife species. Areas protected and restored as aquatic plant habitat would be closely associated with areas protected and restored as tidal brackish and freshwater marsh plant habitat and tidal riparian plant habitat to promote habitat diversity.

Initial efforts should focus on protecting existing aquatic habitat plant community areas. Restored areas should be linked with existing healthy habitats where feasible to provide a source of vegetative propagules and to create large contiguous areas of aquatic plant habitat. Establishing the proper gradients relative to water levels will be key in promoting the establishment of the aquatic habitat plant community. Restored habitats should have natural gradients of open water, shallow water that is suitable for supporting pondweeds, marsh, riparian, and upland habitats to increase the habitat value for a greater diversity of species.

Many leveed lands in the Bay and Delta have subsided and are too low to support shallow waters inhabited by pondweeds, and thus cannot be readily restored. The greatest subsidence has occurred in the Central and West Delta Ecological Management Unit. A comprehensive long-term program would be developed to reverse this process. Changes in land use management, and use of suitable dredged materials or other "natural materials" should be implemented to restore land elevations to suitable ranges.

Restoration efforts should focus on those leveed lands that have not yet been subjected to severe subsidence. Prime candidates are existing managed marshes and salt ponds adjacent to San Pablo and Suisun Bays. Leveed agricultural lands and some industrial lands adjacent to Suisun Bay can be readily restored to the aquatic habitat plant community.